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CHIGNIK LAKES SOCKEYE SMOLT ABUNDANCE, AGE COMPOSITION, AND SIZE CHARACTERISTICS, 1995

By

Thomas D. Vania

and

Charles O. Swanton

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EXECUTIVE SUMMARY

In the spring of 1995, the Chignik Regional Aquaculture Association (CRAA) commissioned the Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division to conduct sockeye salmon smolt outmigration studies in the Chignik Lakes system. The specific study objectives were:

1. Estimate the total number of outmigrant sockeye smolt by age class from the Chignik River system in 1995;
2. Estimate sockeye smolt outmigration timing and growth characteristics (length, weight, and condition) by age class for the Chignik system in 1995;
3. Design and implement experiments related to estimating and accounting for error associated with mark recapture trials used for smolt population estimation;
4. Archive the smolt scales for later scale pattern analysis use in determining stock composition of the 1995 outmigration from future adult returns.

A total of 74,383 sockeye smolts were captured in two rotary-screw traps operated on the Chignik River from 6 May through 30 June. Overall trap efficiency was 1.0%, and the total sockeye smolt outmigration estimate was 11.3 million fish (95% CI 4.1 to 18.6 million). The peak outmigration occurred during 17- 30 May. Age-0 smolts comprised 6.0% of the total outmigration, age-1 smolts comprised 29.9%, and age-2 smolts comprised 64.1%. Delayed mortality of marked smolts was estimated to be 12% but needs to be substantiated with additional data collection and analysis. This mortality estimate if accurate would, in effect decrease the sockeye smolt population estimates. The marked fish detection experiment resulted in 99.8% of marked fish being identified. Based on the estimated number of outmigrating smolts, the total 1998 adult return forecast is 1.9 million fish (95% CI 0.7 to 3.1 million fish). The forecast for age-1. sockeye is 0.6 million, and age-2. 1.2 million fish.

INTRODUCTION

Forecasts of salmon returns are an important aspect of Alaska's commercial salmon fishing industry. The accuracy of forecasts is crucial to fish processors for estimating fish prices, personnel and equipment needs, and to commercial fisherman for timing capital investments. Economically, sockeye salmon *Oncorhynchus nerka* are the most important commercial salmon species in the Chignik Management Area (CMA). Preseason forecast methods in the Chignik River watershed (Figure 1), the primary producer of sockeye salmon in the CMA, are currently based on historic age class relationships and parent year escapement for Black Lake, and average return per spawner for Chignik Lake. The Chignik Lake forecast has historically been variable in its accuracy. From 1984-1993, the percent difference between the preseason forecast and actual run for the Chignik system ranged from 78.0% underforecast to 27.0% overforecast, with an average absolute difference of 17.0% (Stopha and Barrett 1994).

Many of the variables related to the freshwater life history of sockeye salmon within the Chignik Lakes system are not well understood, particularly with regards to the interaction of the Black and Chignik Lakes stocks. The Chignik Regional Aquaculture Association (CRAA) strongly believes that to scientifically evaluate potential habitat enhancement and rehabilitation projects, escapement goals, and management plans, further research is needed. This research includes estimating annual sockeye smolt population numbers, size-at-age, and growth characteristics.

Knowledge of the number, age-class structure, physical condition of outmigrating sockeye smolt and over-wintering juveniles, and the variables that bias mark-recapture results can provide insight into improving current forecasting methods. These variables either directly or indirectly account for a portion of the variability of adult returns caused by changes in freshwater nursery conditions. As the managing agency of the Chignik sockeye runs, the Alaska Department of Fish and Game (ADF&G) is interested in working cooperatively with CRAA for the mutual benefit of the Chignik sockeye salmon resource.

In the spring of 1994, CRAA commissioned ADF&G to conduct sockeye salmon smolt outmigration studies in the Chignik Lakes system. Both parties were satisfied after the completion of the 1994 season that the studies were successful and decided to continue the research. The specific study objectives of the 1995 season were:

1. Estimate the total number of outmigrant sockeye smolt by age class from the Chignik River system in 1995;
2. Estimate sockeye smolt outmigration timing and growth characteristics (length, weight, and condition) by age class, for the Chignik system in 1995;
3. Estimate delayed mortality associated with sockeye smolt marking (dye process).
4. Estimate detection of marked (dyed) fish over time;
5. Archive the smolt scales for later scale pattern analysis use in determining stock composition of the 1995 outmigration from future adult returns.

METHODS

Rotary-screw Traps and Site Description

Emigrating sockeye smolts were enumerated in Chignik River from 6 May through 30 June. Enumeration was accomplished by fishing two rotary-screw traps operating in tandem. Each trap was constructed of a stainless-steel, 2-mm-mesh cone mounted on two aluminum pontoons (Figure 2). The cone entrance diameter was 1.5 m on the inshore trap (small trap), and 2.4 m on the offshore trap (large trap), with one-half (small trap = 1.8 m^2; large trap = 2.2 m^2) of each cone submerged (Ruggerone 1994). The river current propelled an internal screw, rotating the cone approximately 5-11 rpm, depending on river velocity. Fish were funneled through the cone to a live box (small trap = 0.7 m^3; large trap = 0.6 m^3). The large trap livebox was fitted with a rotating perforated stainless-steel drum for debris removal. To prevent mammalian and avian predation, vexar plastic cloth was secured over openings in each of the traps live boxes.

The traps were operated in the Chignik River at a location referred to locally as the "King Hole". The King Hole site, 8.6 km upstream from Chignik Lagoon and 1.9 km downstream from the outlet of Chignik Lake (Figure 3) was a constricted section of river with a width of 46 m and an average depth of 2.7 m. Both traps were scheduled to be fished continuously except during daily cleaning. Traps were tied together and a 10-cm (4-in) x 10-cm (4-in) x 4.9-m (16-ft) plank was lashed across the top of the pontoons, perpendicular to the current, and butted the shore. This served as a fulcrum to maintain and adjust the trap position offshore. Each trap was secured to the riparian vegetation (mature alders) above river flood stage height with polypropylene line.

Traps were positioned as close to shore as possible to allow trap cones to rotate in the current close to the bottom, as well as to minimize hazards to navigation. Initially, the center of the small trap was positioned 4.8 m offshore and 63 cm off the substrate, and the center of the large trap was positioned 8.2 m offshore and 45 cm off the substrate. A 2.4-m lead, constructed of aluminum weir panels and supported by wooden tripods, was placed between the inshore pontoon of the small trap and shore to deflect fish towards the traps. As the water level rose and fell, traps and leads were moved accordingly. An offshore lead was not feasible due to the fast current, excessive depth, and potential for posing a navigational hazard.

Smolt Enumeration

Captured sockeye salmon smolts were removed and enumerated daily from each trap. Traps were checked at least twice daily between 0200 and 1200 h, and again at 2100 h. Traps were checked more frequently as catches increased. All catch data was recorded by sampling day, which extended from noon to noon and was identified by the calendar day of the noon to midnight period (e.g. counts for 5 May represent smolt enumerated from noon 5 May until noon on 6 May).

Species identification of salmonids were made by visual examination of external characteristics (McConnel and Snyder 1972). Only sockeye salmon smolt were enumerated daily, with the presence of sockeye fry and other species noted. Juvenile sockeye greater than approximately

40 mm in length with silvery body coloration and eyes small relative to head size were considered smolts (Thedinga et al. 1994). Similar size fish and smaller with prominent parr marks and large eyes relative to head size were assumed to be fry and were not enumerated. All juveniles greater than about 55 mm were considered to be outmigrating smolts, regardless of coloration or proportional body morphology.

Age, Weight, and Length Sampling

Subject to availability, seventy sockeye smolts were sampled daily, five days a week. The sample was generally obtained between 0200 and 0500 h using a dip net to remove the sample from the live box. Smolts were kept alive and sampled on the day of capture. Sampled smolts were anesthetized in a tricaine methanesulfonate (MS-222) solution, and measured for length (tip-of-snout to fork-of-tail) to the nearest 1.0 mm, and weighed to the nearest 0.1 g. A scale smear was removed from the preferred area (INPFC 1963) and mounted on a standard microscope slide for ageing with a microfiche reader under 42X or 48X magnification (Figure 4). Ages were recorded in European notation (Koo 1962). After sampling, fish were revived in aerated water and released downstream from the traps. Condition factor (K) for each smolt sampled was determined using:

$$K = \frac{W * 10^5}{L^3} \qquad (1)$$

where:
W = weight in grams and L = length (tip-of-snout to fork-of-tail) in millimeters (Barrett et al. 1993).

Estimation of Trap Efficiency

Trap efficiency was estimated weekly through mark-recapture experiments using Bismark Brown dye to mark smolt. Smolts used for trap efficiency trials were collected from the traps and transferred in 19 L plastic buckets to instream covered live boxes. Smolt were retained for a minimum of 10 hours to a maximum of three nights prior to dyeing, depending on smolt availability. If the target number of smolts collected for dyeing was not met after three nights, those available were dyed and released. Initially, an attempt was made to mark and release at least 1,000 sockeye smolt weekly. Later the target sample size was increased to 2,000 smolts to test variability in trap efficiency relative to numbers of releases.

Smolts were dyed in the evening at approximately 1900 hours. Smolts were transferred from the live boxes into a continuously oxygenated or aerated solution of 1.9 g Bismark Brown dye to 57 L water (Ward and Verhoeven 1963; Lawler and Fitz-Earle 1968) for 30 minutes at a rate of up to 1,000 smolt/76 L dye solution. After the dyeing process, smolts were returned to the liveboxes and held for about three hours to allow for recovery. At approximately 2230 hours, dyed smolts were collected from the liveboxes, transported 1.3 km upstream from the traps (Figure 3), and

released evenly across the stream channel. At each step of the dyeing process, dead or stressed smolts were counted and removed.

Following the release of dyed fish, trap catches were examined for recaptures for three days. Recaptured smolts were recorded separately from unmarked fish and excluded from daily catch totals.

In deriving trap efficiency from the mark-recapture and trap catch data the formula used was:

$$\hat{e}=\frac{d_t}{D} \qquad (2)$$

where d_t = number of marked fish recaptured over (k) successive nights after release, and D is the number of marked fish released,

$$d_t=\sum_{i=1}^{k} d_i .$$

Rawson (1984) reported statistical models for treating sockeye smolt mark-recapture data derived on a daily basis with population estimates generated by:

$$\hat{N}_i=n_i\left[\frac{D}{d_t}+\frac{(D-d_t)}{d_t^2}\right]; \qquad (3)$$

with variance:

$$Var\left[\hat{N}_i\right]=n_i(n_i+d_t)\ D(D-d_t)/d_t^3 . \qquad (4)$$

The overall annual smolt outmigration was estimated by:

$$\hat{N}=\sum_{i=1}^{k}\hat{N}_i; \qquad (5)$$

with the overall variance estimated by:

$$Var\left[\hat{N}\right]=\sum_{i=1}^{m} Var\left[\hat{N}_i\right] \qquad (6)$$

where:

i) $\hat{N}_i$= *Total population of smolt outmigrating on day i;*

ii) n_i= *Number of unmarked fish captured by traps during day i;*

iii) $\hat{N}$= *Total smolt population outmigrating during k days.*

The (1-α) confidence intervals for the smolt population estimates were derived assuming a normal distribution (Rawson 1984). Trap efficiency for the large trap on 5 and 6 May, prior to installation of the small trap, was estimated as the product of: 1) the average percent contribution of the large trap catch to the combined catch of both traps from 7 May through 12 May; and 2) the overall mean trap efficiency for that week. For 4 June, when the small trap was inoperable, the trap efficiency was estimated as the product of: 1) the mean percent contribution of the large trap catch to the combined catch of both traps on 13 and 15 June; and 2) the overall mean trap efficiency for that week. A chi-square test was used to test homogeneity (α=0.05) among weekly mark-recapture events.

There are two components related to estimating and accounting for error associated with mark-recapture trials used for smolt population estimation that have not been previously quantified. The first is whether or not significant delayed mortality exists after sockeye smolt are marked and released; and the second is detection of marked fish over time as the dye mark deteriorates. These variables could bias the mark-recapture results and thus bias the smolt population estimates, either high or low, if significant mortality or lack of dye detection exists.

Delayed Mortality Associated With Marked Fish

An instream live box was constructed for mortality experiments for estimating marked smolt mortality that occurs over time after having been subjected to the dye process. The live box was 0.9 m (3-ft) wide x 1.5 m (5-ft) long x 0.9 m (3-ft) deep with perforated side and end panels, and divided into ten separate 30 cm (1-ft) x 46 cm (1.5-ft) compartments. Compartments on one side of the live box were labeled "Unmarked" and numbered 1 - 5; with the opposite side being labeled "Marked" and numbered 1-5. The live box was placed across the river from the traps parallel to the flow, in slow moving water adjacent to the river bank to facilitate ease of examination.

A minimum sample size of 500 sockeye smolts was obtained from the trap live box and placed in the instream live box used for dyeing smolt (I.Vining, Alaska Department of Fish and Game, Kodiak, personal communication). The sample was then divided into two equal groups. One group was subjected to the same dye process that was used for mark-recapture trials (i.e. dye concentration, emersion period, aeration, recovery time, and transport procedures). Groups of 47 marked smolts were then placed into each of the five compartments labeled "Marked" for a total of 235 marked smolts. The second group of smolts were left unmarked but were also subjected

to the same handling procedures that were used for mark-recapture trials (i.e. aeration, recovery time, and transportation) and placed into five compartments for unmarked smolts. Only robust and healthy smolts were placed in the live box; this categorization was defined as actively swimming fish maintaining routine respiration and responding to external stimuli. Any smolts not displaying this behavior were released down stream of the trap.

After 24 hours had elapsed following the dye process, the first group (contained within compartment No's. 1-marked and unmarked) were inspected for mortality, counted, recorded, and released downstream of the traps. This same process was repeated each day at the same time until all smolts associated with the experiment had been released (five days later). This experiment was to be conducted about once weekly over four weeks.

Detection Of Marked Smolt Over Time

Another instream live box was constructed to determine whether dyed smolt can be detected over time. The live box was 0.9 m (3-ft) wide x 1.5 m (5-ft) long x 0.9 m (3-ft) deep with perforated side and end panels. The live box was divided into two equal compartments, labeled "Marked" and "Unmarked", and placed adjacent to the other live boxes. A sample size of 300 sockeye smolts was obtained from the trap live box and 150 unmarked smolts were placed directly into the "Unmarked" live box compartment. The remaining 150 smolts were subjected to the same dye process that was used for mark-recapture trials except that marked smolts after the dye process were placed directly into the "Marked" compartment of the live box.

Envelopes were provided for each crew member containing random numbers of marked and unmarked fish that were to be placed into a dipnet and given to the other crew person for inspection each night of the experiment. One crew member opened the provided envelope and removed the first set of random numbers. Indicated numbers of marked and unmarked fish from the live box were placed into a dipnet and handed to the other person for counting. Numbers of marked and unmarked fish identified by the second person were recorded and the process was repeated with a second and third set of numbers. Then crew roles were reversed and the process again repeated. Time of night, artificial light sources, dipnets employed, and time spent on inspection and handling of smolts simulated normal working conditions. The experiment was to be conducted about once weekly, for five consecutive nights, until four weekly replicates were completed.

Climate and Hydrology

Trap revolutions per minute and daily climate observations, including air and stream temperature (°C), stream height (cm), cloud cover (%), wind velocity (mph) and direction were recorded at about 1155 daily at the trap site.

RESULTS

The smolt traps operated from 6 May through 30 June 1995 during which time 74,383 outmigrating sockeye salmon smolts were captured. During 28-29 May the large trap malfunctioned but was operational again on 30 May. A total of 6,197 sockeye smolts were dyed and released upstream of the traps, resulting in 62 recaptures (Appendix A). Since mark-recapture trap efficiencies were estimated on approximately a weekly basis, we tested for homogeneity between events and the pooled seasonal trap efficiency. For the 1995 trap efficiency values, significant test statistics were generated ($df=6$, $P<0.01$), therefore we employed linear interpolation between weekly trials to generate daily trap efficiencies. The total estimated sockeye smolt outmigration was 11.3 million fish (Table 1; Figure 5). Age-0 smolts comprised about 6.0% (674,000) of the outmigration, age-1 smolts approximately 29.9% (3,378,000), and age-2 smolts 64.1% (7,261,000; Table 2). Overall, 79.2% of the sockeye smolts were caught in the large trap, and 20.8% in the small trap (Appendix B). Other species captured included coastrange sculpin *Cottus aleuticus*, coho salmon *O. kisutch*, Dolly Varden *Salvelinus malma*, ninespine stickleback *Pungitius pungitius*, pond smelt *Hypomesus olidus*, pygmy whitefish *Prosopium coulteri*, starry flounder *Platichthys stellatus*, and threespine stickleback *Gasterosteus aculeatus*.

The smolt outmigration peak occurred on 25 May (Figure 6, Appendix C). Age-0 smolt outmigration peaked during the week of 31 May (Figure 7). The percentage of age-0 smolts increased from 5.3% during 6-20 May to 6.3% during 12-29 June (Appendix D). Age-1 smolt outmigration peaked during the week of 24 May, then steadily declined before a small increase during the week of 21 June (Appendix D). The percentage of age-1 smolts increased from 17.4% during 6-20 May to 84.9% during 12-29 June (Figure 8). Age-2 smolt outmigration peaked during the week of 24 May and steadily declined through 28 June. The percentage of age-2 smolts declined from 77.3% during 6-20 May to 8.7% during 12-29 June. The decline of age-2 smolts over time is typical of sockeye smolt migrations because larger and older smolts tend to emigrate earlier in the season (Figures 9-10; Ruggerone 1994).

A total of 2,570 smolts were sampled for age, weight, and length data (Appendix E). The mean length of age-0 smolts was 45 mm. The mean length of age-0 smolts declined from 46 mm during 6-20 May to 43 mm during 12-29 June. The mean length of age-1 smolts was 60 mm and showed a decline over time from 76 mm during 6-20 May to 55 mm during 21-29 June. The overall mean length of age-2 smolts was 75 mm with mean lengths increasing over time from 75 mm during 6-20 May to 76 mm during 12-29 June (Appendix F). Comparison between mean length and weight of age 1. and 2. fish depict slightly larger smolts outmigrated during 1994 than in 1995 (Table 3).

Daily Climatological observations are provided in Appendix G.

Delayed mortality experiments were slated to be conducted over the span of four weeks, however only two replicates were completed. Average marked smolt mortality was 23%, and average unmarked smolt mortality 11%. The difference between the average marked versus unmarked mortality for both weeks was 12%. An identical experiment conducted at Red Lake on Kodiak Island during 1995 resulted in a average difference of 15% (Swanton et al. 1996). The marked fish detectability experiments showed that there was no difference between observers (experienced

versus inexperienced; chi-square test df=1, P>0.95) at either Chignik or Red Lake; estimates of marked fish were detected at a rate of 99.83% at Chignik, and 99.67% for Red Lake during 1995.

DISCUSSION

During 1994, the trap was located below a Rough-Legged Hawk *Buteo lagopus* nest at a site referred to locally as "Hawks Bluff". Initially a female hawk nested at the site for several weeks before it abandoned the nest. Local concern over the nest prompted a relocation of the trap site to the King Hole. Permission was obtained from the Chignik Lake village council to install a weather-port and platform adjacent to the trap site to facilitate the smolt operation. The weather-port and platform were removed upon completion of the project. The hawk did return to the Hawk's Bluff nest this season and was observed successfully nesting and rearing an offspring.

The King Hole site had a width of 46 m as compared to a width of 73 m at Hawk's Bluff. This narrow constriction of river possibly contributed to the increased overall trap efficiency of 1.0% in 1995 as compared to 0.5% in 1994 (Stopha and Barrett 1994). Trap efficiency results varied from a high of 1.8% to a low of 0.6%. The high efficiency of 1.8% caused a significant difference among weekly mark-recapture events. It is recommended based on 1994 and 1995 data that mark-recapture events occur more frequently to reduce influence of individual events. Conducting mark-recapture trials every four days as opposed to seven should improve the trap efficiency results, thus reducing the variance around the smolt population estimates.

The differential growth between juvenile salmon rearing in Black Lake and Chignik Lake may be used to identify sockeye smolt origin. Sockeye salmon fry rearing in Black Lake emerge earlier and grow at a faster rate than fry rearing in Chignik Lake (Narver 1966). Studies of the lacustrine life of Black Lake juveniles indicate that a portion of yearlings rear in Black Lake, while others emigrate to Chignik Lake (Roos 1959; Narver 1966; Ruggerone et al. 1993; Ruggerone 1994). The contrast in growth rates between Black Lake and Chignik Lake rearing fry and outmigrating smolt might be reflected in length-frequency distributions and when measured may be used to distinguish Black Lake from Chignik Lake sockeye. Without several additional years of data, a quantitative comparison cannot be made.

A cursory analysis of length-at-age data indicates three populations of age-1 smolts. A small mode of age-1 smolts between 65 and 90 mm (average 73 mm) outmigrated during May and the first week of June, suggesting that these fish may be of Black Lake origin which overwintered in Chignik Lake (Ruggerone 1994). A larger mode of age-1 smolts ranging between 43 mm and 64 mm (average 53 mm) outmigrated during mid to late June and may be of Chignik Lake origin. A few larger age-1 smolts of presumably Black Lake origin overwinter in Black Lake. These large smolt averaged 98 mm (range: 91-110 mm) and were < 3.0% of the presumed Black Lake smolt outmigration.

The large mode of age-2 smolts between 63 and 90 mm (average 74 mm) suggests that these fish may be from the Chignik Lake stock. A few age-2 smolts (<5.0% of the Black Lake smolt outmigration) averaged 99 mm (range: 91-112 mm) and may represent slow-growing Black Lake smolt that overwintered in Chignik Lake.

An unknown portion of age-1 smolts <55 mm and age-0 smolts may rear in the river or lagoon, migrate upstream to Chignik Lake as rearing juveniles, or emigrate to sea (Iverson 1966). Typically, few adults (<1.0% or about 20,000 fish) having spent less than one year in freshwater return to Chignik and Black Lakes (Quimby and Owen 1994).

Previously collected smolt length-at-age data (1957, 1958, 1992, and 1994) had greater mean lengths for both age classes than those in 1995. The difference in mean lengths between 1994 and 1995 may have been less than indicated due to the sampling bias in 1994, which identified smolts as being greater than or equal to 55 mm. The percentage of age-2 smolts was greater than age -1 smolts, similar to 1957 and 1958 results which produced larger runs to Chignik Lake than to Black Lake (Quimby and Owen 1994). Based on daily catches and interpolated estimates of stock composition from length-at-age data, a stronger run of Chignik Lake adults and a weaker run of Black Lake adults should be expected in 1998.

The marked versus unmarked mortality experiment's data analysis was limited to comparisons of average survival between the two groups because few replicates were conducted. A similar experiment conducted for sockeye salmon on the Situk River estimated marked fish survival at 95% (Thedinga et al. 1994). This is substantially higher than our 1995 estimate of 88%. We propose to conduct the mortality experiments again during the 1996 field season, with modifications, to confirm or refute the limited marked smolt mortality data collected during 1995. If this mortality estimate holds true then the smolt population estimates generated during 1994 and 1995 will be adjusted accordingly.

A forecast can be made based on the estimated outmigration of sockeye smolt, using the 16.7% (SE=9.8%) smolt-to-adult survival ratio estimator developed by Koenings et al. (1993) for small smolts (length 55 mm to 84 mm) for middle latitude (56°N to 60°N) sockeye nursery lakes. Assuming a normal distribution, this results in a 1998 forecasted total return of about 1.9 million fish (95% CI 0.7 to 3.1 million fish). The age-1.x forecast (29.9% of the total) is 0.57 million fish and the age-2.x forecast (64.1% of the total run) is 1.2 million fish. This is a preliminary forecast and is currently not used in the development of a formal preseason forecast for management purposes because too few data points exist.

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Table 1. Sockeye salmon smolt population estimates and age composition for the Chignik Lakes system, 1993-1995.

Smolt Year		Smolt Population Estimate and Age Composition (%) Age-0	Age-1	Age-2	Total	95% CI Low	95% CI High
1993	No.	[a]	25,397,684	8,754,782	34,152,467[b]	2,607,046	65,697,887
	%		74.4	25.6	100.0		
1994	No	[a]	7,736,438	5,016,654	12,753,093	12,317,017	13,245,169
	%		60.7	39.3	100.00		
1995	No.	673,867	3,378,427	7,261,223	11,313,517	4,062,384	18,564,649
	%	6.0	29.9	64.1	100.0		

[a] Population estimates not available.

[b] In 1993, only two marked smolts were recaptured out of a total of 10,617 marked releases. The two smolts were caught during a weekly mark-recapture experiment in which 1,000 dyed smolts were released (Ruggerone, 1994). This single recapture event (trap efficiency = 2/1000 or 0.02%) was used to compute the 1993 population estimate resulting in the correspondingly large confidence interval. The reliability of this estimate is therefore questionable, and likely an overestimate (Ruggerone 1994).

Table 2. Sockeye salmon escapement and estimated number of smolt produced by brood year from Chignik and Black lakes, 1990-1992.

Brood Year	Estimated Escapement by Lake System		Smolt Produced by Age Class (Both Lakes Combined) 1.	2.	Total No. Smolts
1990	Black :	434,543	[a]	8,754,782[b]	8,754,782[c]
	Chignik :	335,867			
1991	Black :	657,511	25,397,684[b]	5,016,654	30,414,338
	Chignik :	382,587	(84%)	(16%)	
1992	Black :	360,681	7,736,438	7,261,223	14,997,661
	Chignik :	405,922	(52%)	(48%)	

[a] Population estimates not available.

[b] In 1993, only two marked smolts were recaptured out of a total of 10,617 marked releases. The two smolts were caught during a weekly mark-recapture experiment in which 1,000 dyed smolts were released. (Ruggerone 1994). This single recapture event (trap efficiency = 2/1,000 or 0.02%) was used to compute the 1993 population estimate resulting in the correspondingly large confidence interval. This smolt population estimate is therefore questionable, and likely an overestimate (Ruggerone 1994).

[c] Incomplete brood year data.

Table 3. Summary of mean length, weight, and condition factor by age class of smolt sampled from the Chignik River, 1994-1995.

Outmigration Year	Freshwater Age Class	N	Smolt Mean Length (mm)	SE	Mean Weight (g)	SE[a]	Condition Factor (k)	SE
1994	0	[b]	[b]		[b]		[b]	
1995	0	286	45.7	0.2	0.7		0.74	0.01
1994	1	1,722	66.6[c]		2.3		0.75	
1995	1	1,275	60.2	0.3	2.0		0.83	0.01
1994	2	1,096	77.4		3.6		0.75	
1995	2	1,009	75.1	0.2	3.5		0.80	0.01

[a] Standard errors for weight estimates were less than the precision level of measurement (0.1g) therefore they were not reported.

[b] Age-0 smolts not sampled.

[c] Age-1 smolts <55 mm not sampled.

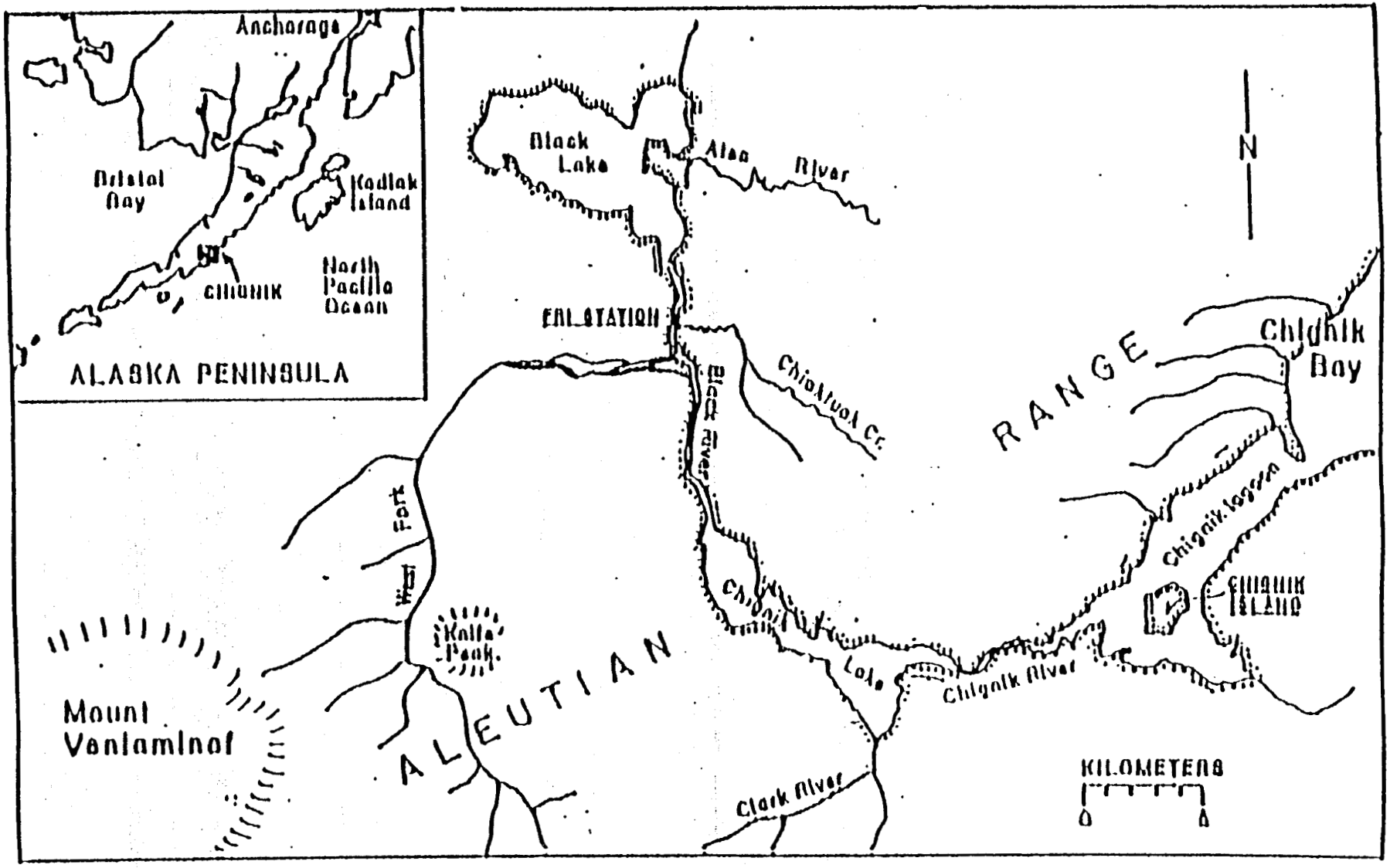
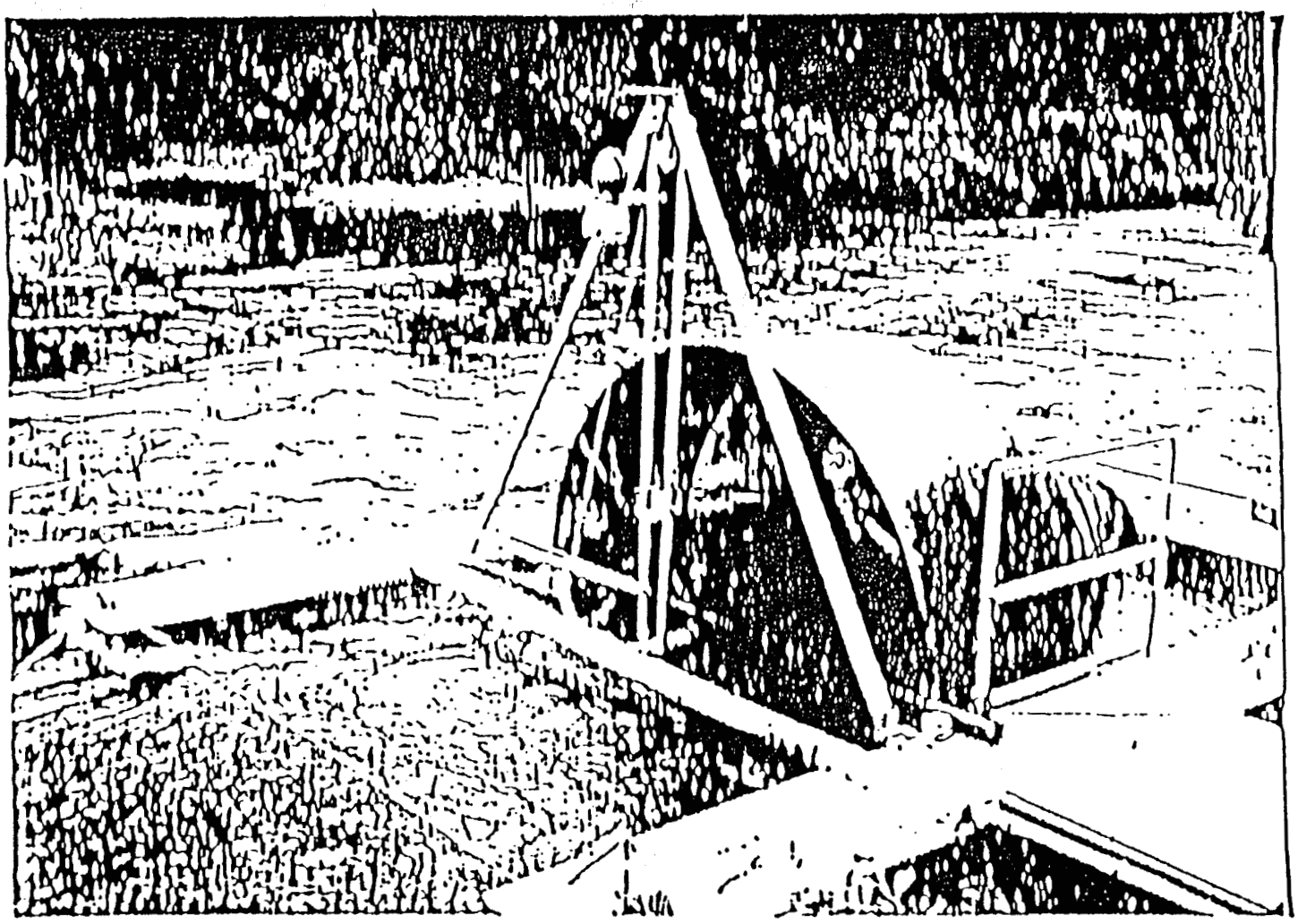


Figure 1. Map of the Chignik River watershed with inset of western Alaska.



(Thedinga et al. 1994)

Figure 2. Photograph of a rotary-screw trap with a 2.4 m diameter cone.

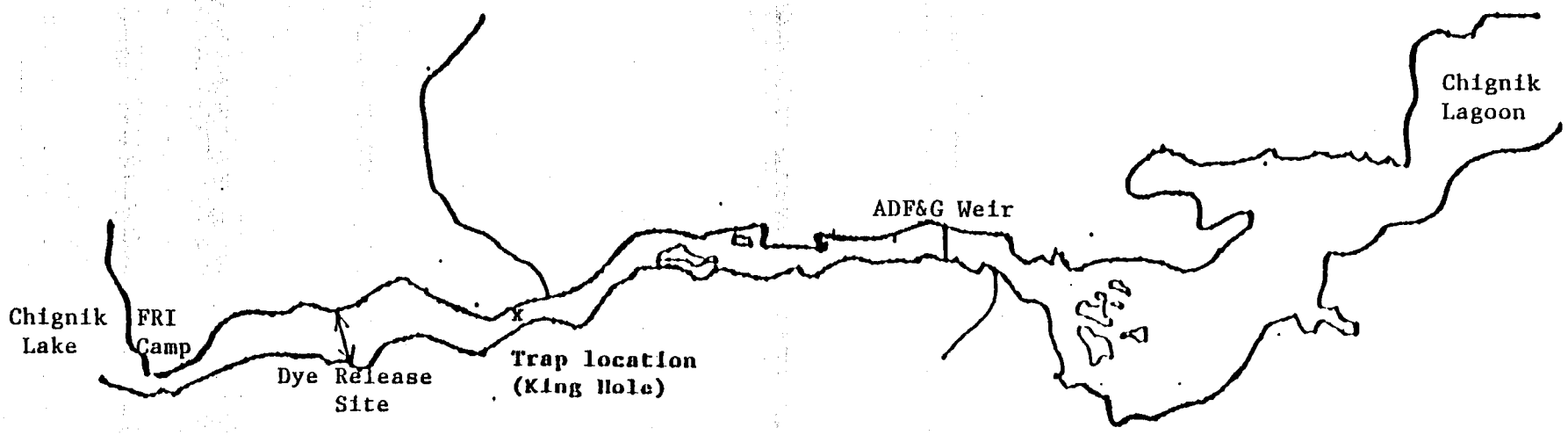


Figure 3. Location of rotary-screw trap (denoted by "x"), and release site of dyed fish on the Chignik River, Alaska

Age-0
Length:46 mm
Weight: 0.7g
May 12, 1995

Age -0
Length: 47 mm
Weight: 0.9 g
June 9, 1995

Age-1
Length: 78 mm
Weight: 3.4 g
May 12, 1995

Age-1
Length: 105 mm
Weight: 10.9 g
June 9, 1995

Age-2
Length: 86 mm
Weight: 4.8 g
May 12, 1995

Age-2
Length: 101 mm
Weight: 9.7 g
June 9, 1995

Figure 4. Examples of age-0, age-1, and age-2 sockeye salmon smolt scales (54x), Chignik River, 1995.

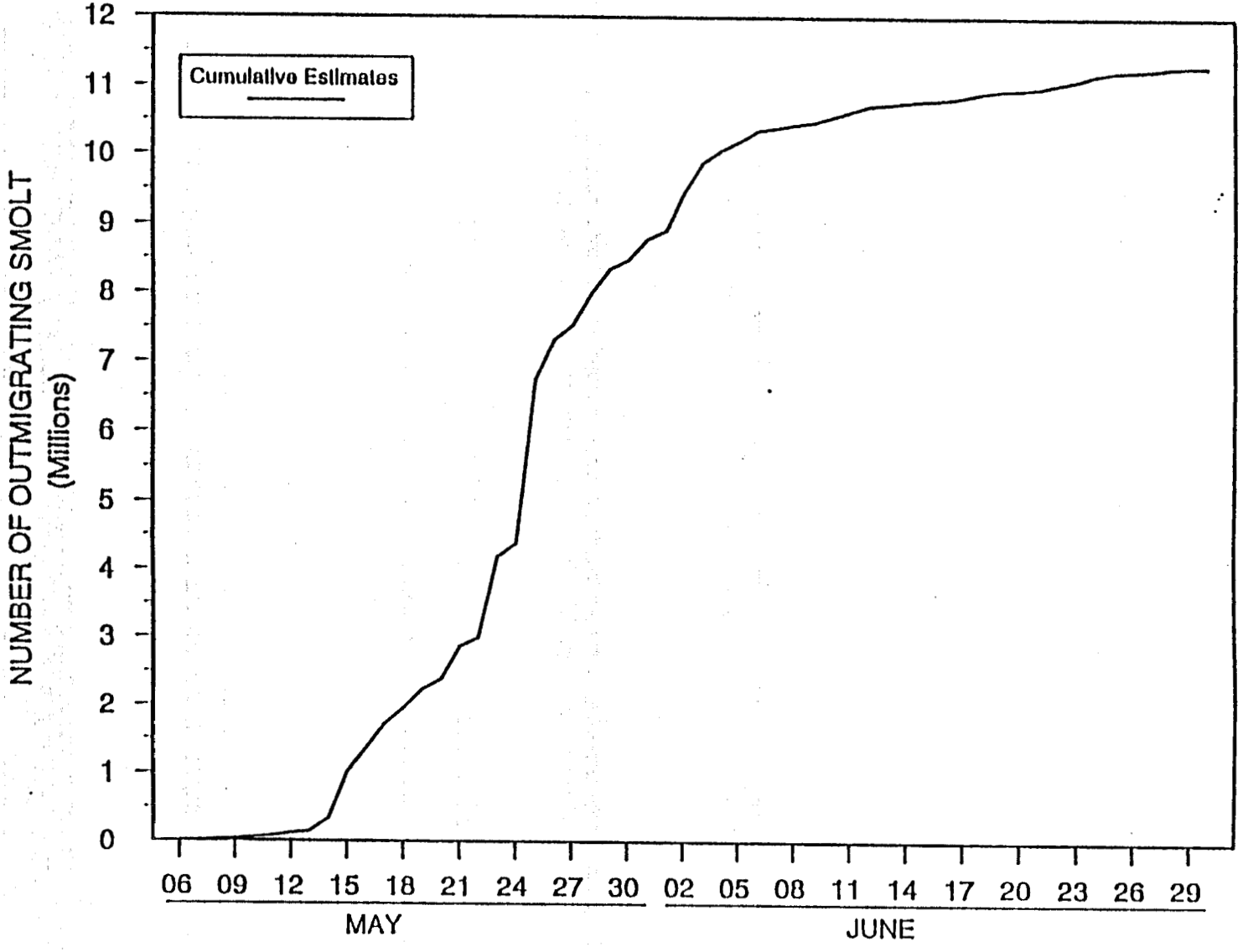


Figure 5. Number of sockeye smolt estimated to have emigrated from Chignik Lakes, 1995.

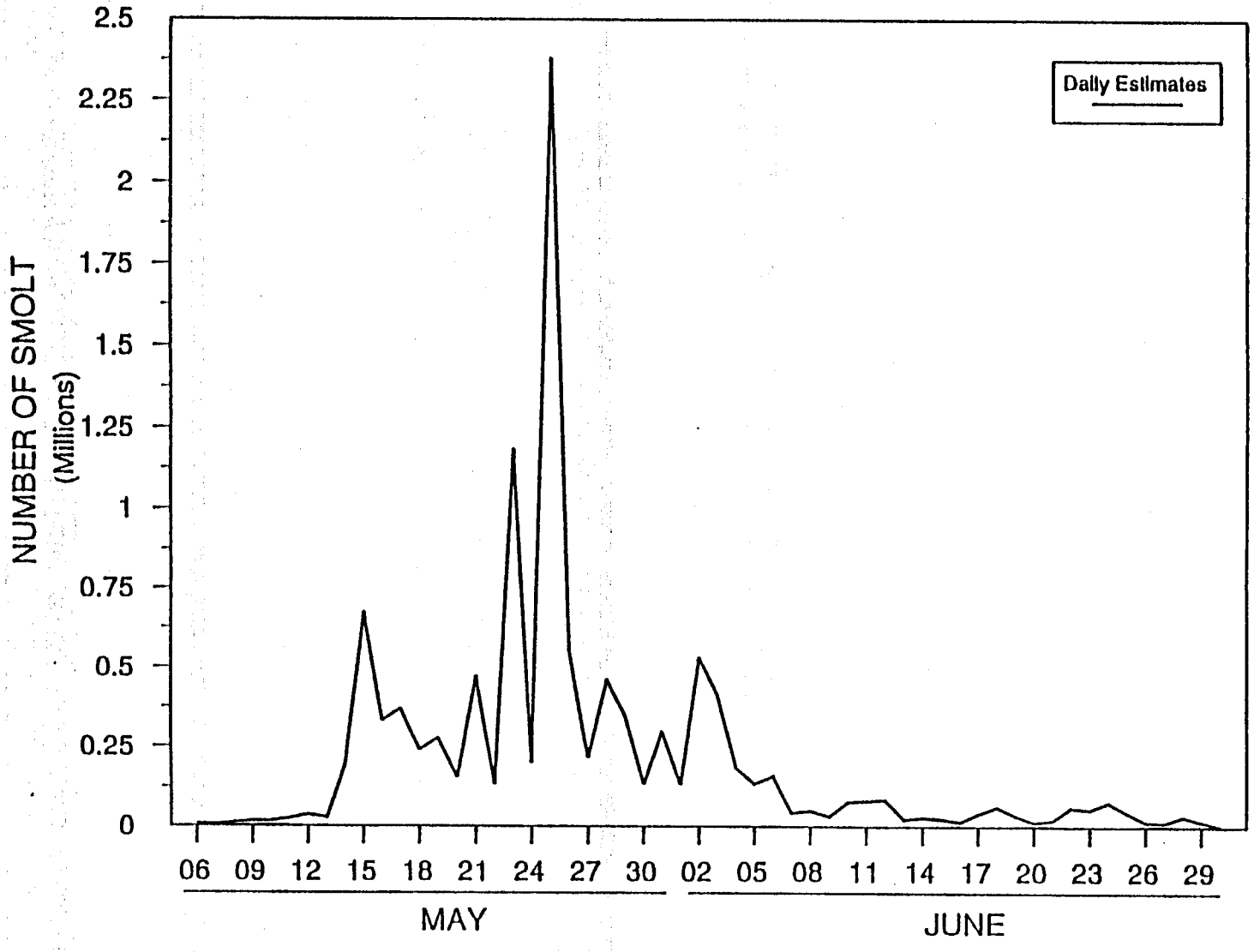


Figure 6. Daily estimated numbers of outmigrating sockeye smolt from Chignik Lakes by week, 6 May to 30 June, 1995.

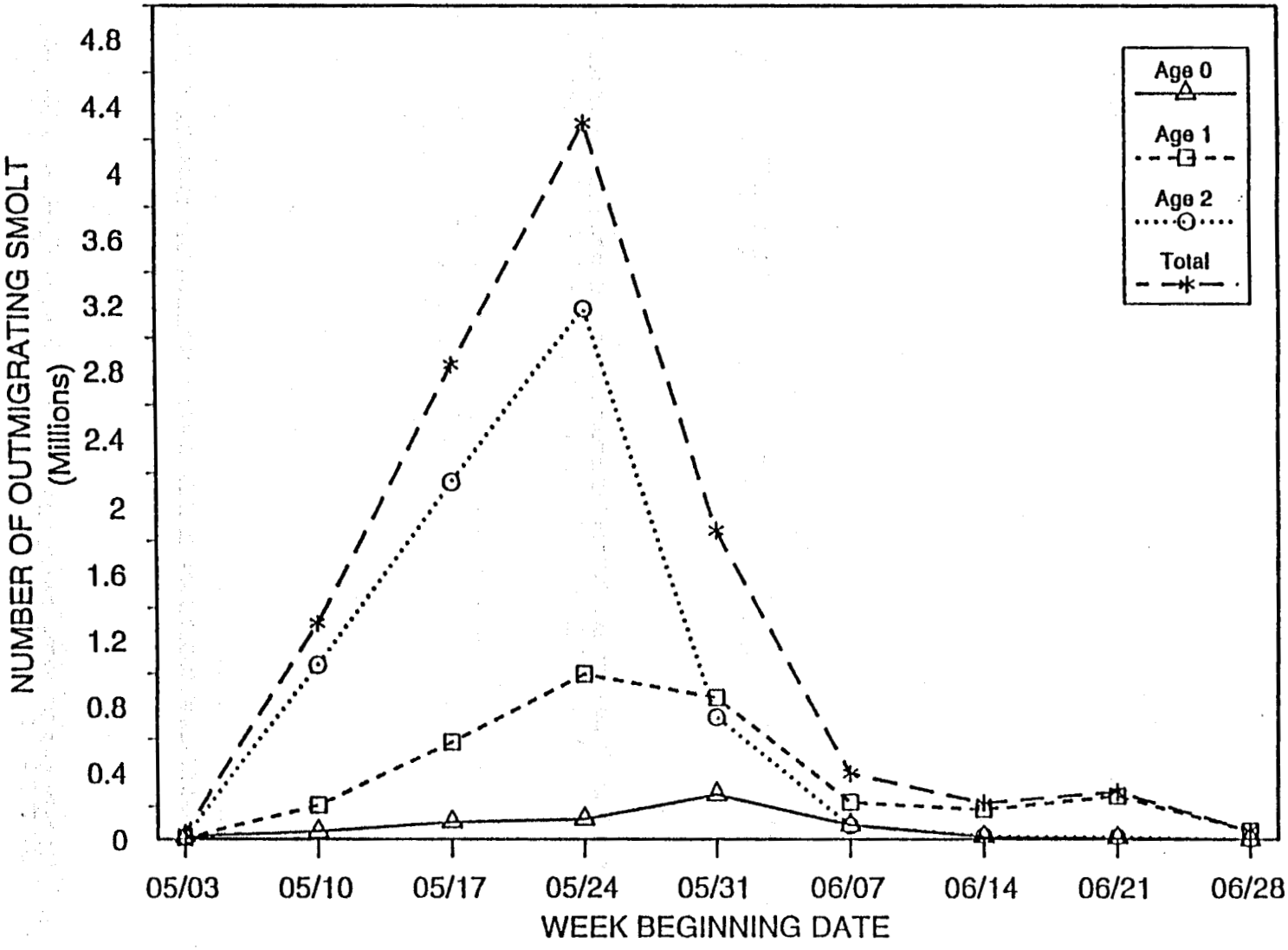


Figure 7. Weekly estimated numbers of outmigrating sockeye smolt by age class from Chignik Lakes, 1995.

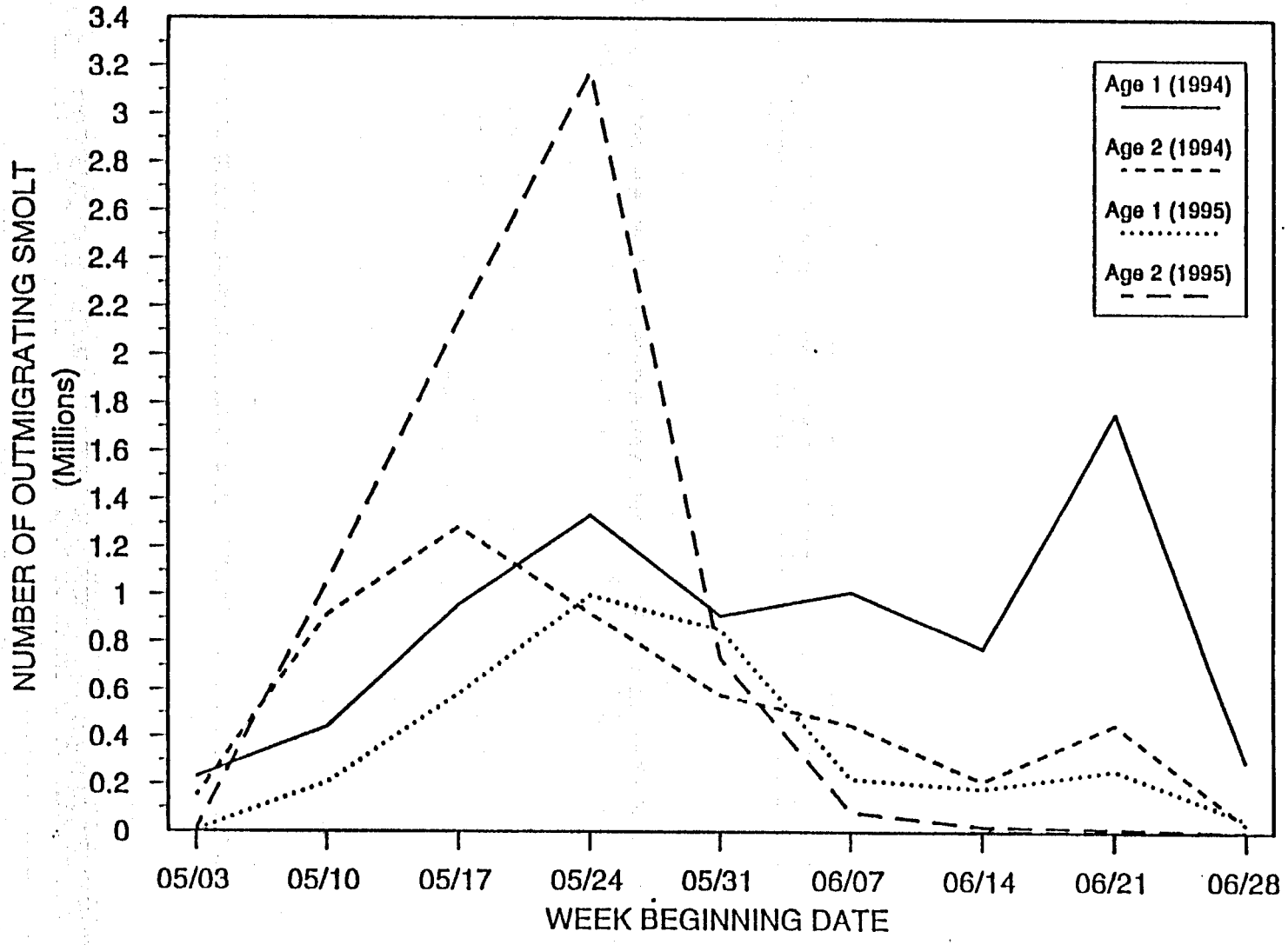


Figure 8. Weekly estimated numbers of age-1 and age-2 outmigrating sockeye smolt from Chignik Lakes, 1994 and 1995.

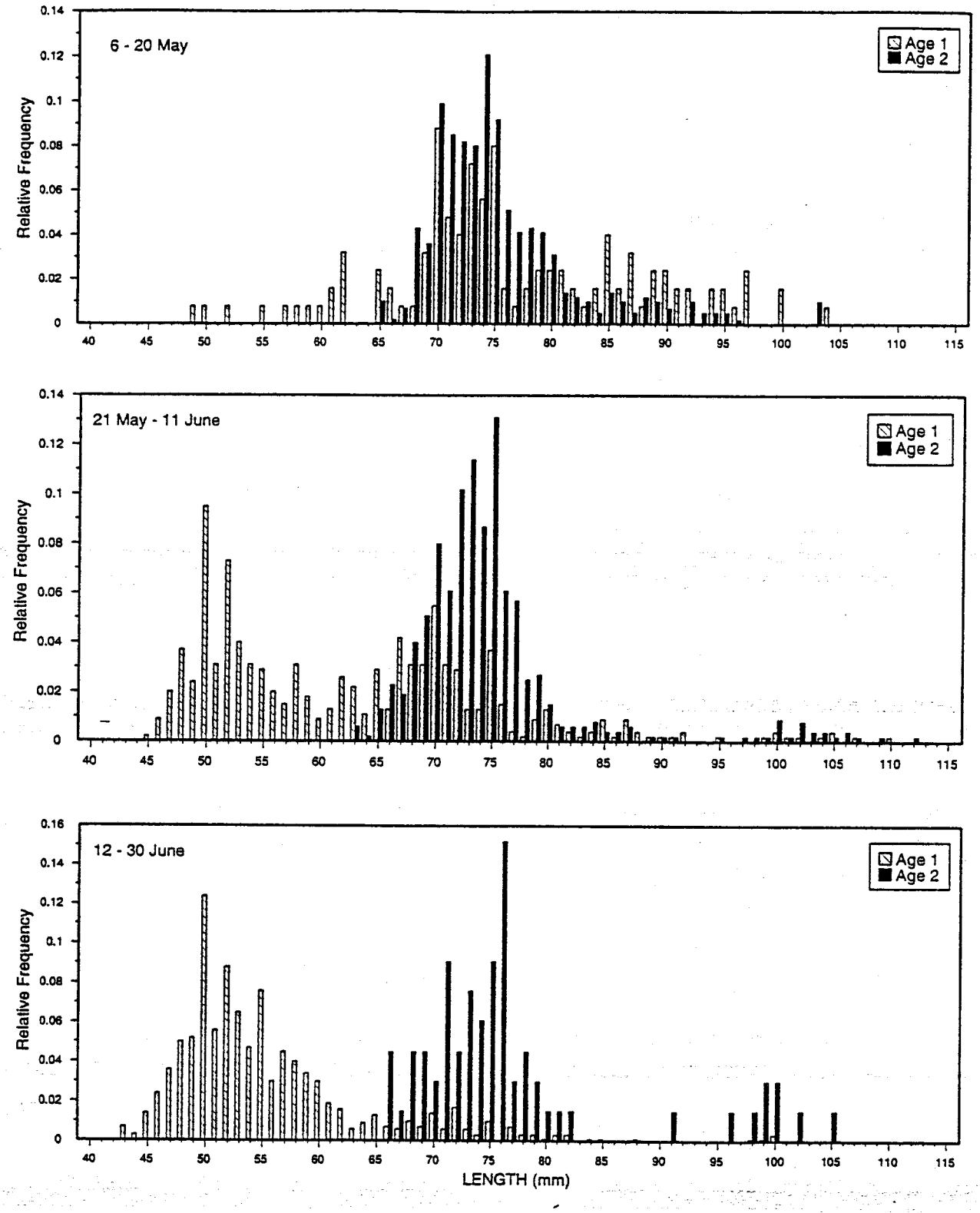


Figure 9. Relative frequency of age-1 and age-2 outmigrating sockeye smolt from Chignik Lakes, 6 May - 30 June, 1995.

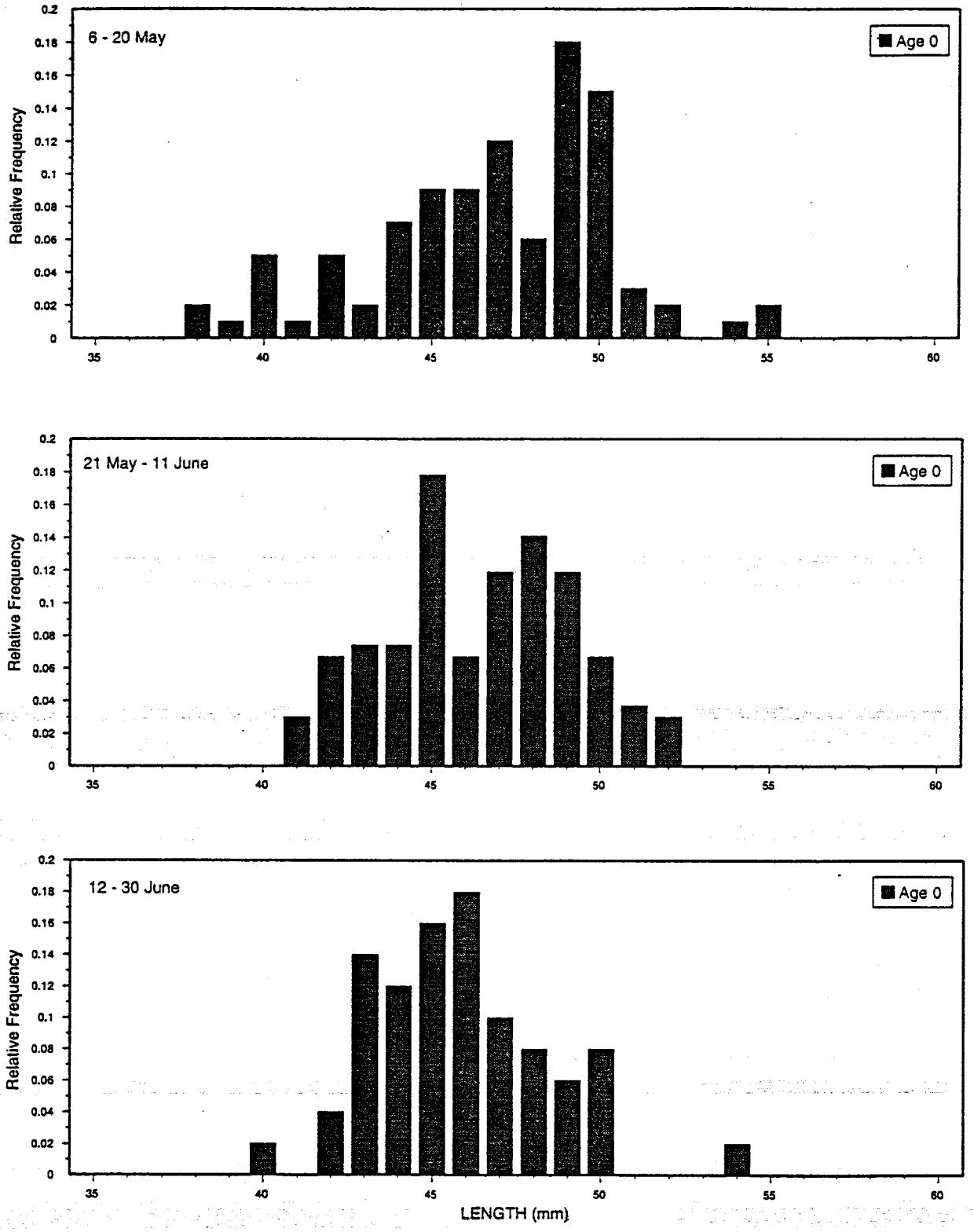


Figure 10. Relative frequency of age-0 outmigrating sockeye smolt from Chignik Lakes, 6 May - 30 June, 1995.

APPENDIX

Appendix A. Daily number of sockeye salmon smolt caught with rotary-screw traps operated on the Chignik River, 1995.

	Combined Trap Catch[a]		Trap Efficiency Test					
Date[b]	Daily[c]	Cum.	Marked (Dyed)	Examined For Marks	Marked Recoveries	Est. Marked Recoveries For Dye Test Period[d]	Recovery Rate%[e]	Comments
06-May	43	43	0	0				Sm. trap begins fishing @ 1800 hrs Lrg. trap begins fishing @ 1900 hrs
07-May	31	74	0	0				Placed inshore lead to traps; mink sign at trap, added screen to cover live box
08-May	74	148	0	0				
09-May	100	248	0	0				
10-May	104	352	0	0				
11-May	153	505	0	0				Moved traps and lead inshore
12-May	224	729	148	226	2	2	1.35%	Both recaps in sm. trap
13-May	169	898	0	169	0			
14-May	1,196	2,094	0	1,196	0			Mink sign again at trap
15-May	4,145	6,239	997	4,152	7	7	0.70%	High tide (10.6 ft) @ 0530 hrs
16-May	2,044	8,283	0	2,044	0			Placed screen over debris drum opening
17-May	2,276	10,559	0	2,276	0			No mink sign at trap
18-May	1,458	12,017	0	0				
19-May	1,629	13,646	0	0				
20-May	886	14,532	0	0				
21-May	2,633	17,165	0	0				
22-May	732	17,897	0	0				Moved traps and leads inshore
23-May	6,240	24,137	0	0				
24-May	1,093	25,230	944	1,094	1	6	0.64%	Large amount of vegetation in live boxes
25-May	12,976	38,206	0	12,980	4			High percentage of catch occured 0300 - 0400
26-May	3,031	41,237	0	3,032	1			
27-May	1,338	42,575	0	0				
28-May	3,152	45,727	0	0				Lrg. trap inoperable, broken shaft.
29-May	2,638	48,365	0	0				Interpolated data from small trap catch.
30-May	1,114	49,479	0	0				Lrg. trap resumes fishing at 1200 hrs
31-May	2,674	52,153	0	0				
01-Jun	1,061	53,214	1,147	917	8	10	0.87%	Removed 152 smolt prior to dye/release
02-Jun	4,232	57,446	0	4,233	1			
03-Jun	3,321	60,767	0	3,322	1			
04-Jun	1,409	62,176	0	0				
05-Jun	980	63,156	0	0				
06-Jun	1,098	64,254	0	0				
07-Jun	288	64,542	0	0				
08-Jun	414	64,956	864	422	8	8	0.93%	Caught several recaps within 1/2 hr. of release

-Continued-

Appendix A. (Page 2 of 2).

Date[b]	Combined Trap Catch[a] Daily[c]	Cum.	Trap Efficiency Test Marked (Dyed)	Examined For Marks	Marked Recoveries	Est. Marked Recoveries For Dye Test Period[d]	Recovery Rate%[e]	Comments
09-Jun	269	65,225	0	269	0			
10-Jun	645	65,870	0	645	0			
11-Jun	1,049	66,919	0	0				
12-Jun	1,470	68,389	0	0				
13-Jun	523	68,912	0	0				Dead beaver in lrg. trap live box
14-Jun	515	69,427	1,315	492	19	24	1.83%	Removed 42 smolt prior to dye/release
15-Jun	439	69,866	0	444	5			
16-Jun	282	70,148	0	282	0			Noticed king smolt - 14
17-Jun	650	70,798	0	0				Weld on lrg. trap shaft seperated
18-Jun	886	71,684	0	0				20 king smolt
19-Jun	446	72,130	0	0				6 king smolt
20-Jun	164	72,294	0	0				4 king smolt
21-Jun	202	72,496	0	0				20 king smolt
22-Jun	476	72,972	0	0				24 king smolt
23-Jun	342	73,314	0	0				29 king smolt
24-Jun	368	73,682	0	0				20 king smolt
25-Jun	245	73,927	782	162	5	5	0.64%	Removed 88 smolt prior to dye/release
26-Jun	90	74,017	0	90	0			27 king smolt
27-Jun	73	74,090	0	72	0			16 king smolt
28-Jun	182	74,272	0	0				4 king smolt
29-Jun	93	74,365	0	0				18 king smolt
30-Jun	18	74,383	0	0				15 king smolt
Total	74,383		6,197	38,519	62	62	1.00%	

[a] Traps fished had cone diameters of 1.5 m (small trap) and 2.4 m (large trap).

[b] Each date listed covers a 24-hr period extending from noon to noon and identifies the date of the first noon of the 24-hour period.

[c] Number of fish caught does not include mark recoveries from trap efficiency tests.

[d] Represents the estimated sum of marked recoveries for the particular dye test period.

[e] Determined from the cumulative number of marked and recovered fish by test period.

Appendix B. Daily number of sockeye salmon smolt caught by trap in the Chignik River, 1995.

Date	Small Trap Daily	Small Trap Cumulative	Large Trap Daily	Large Trap Cumulative	Combined Daily	Combined Cumulative	Small Trap % of Combined Daily Catch	Large Trap % of Combined Daily Catch
05/06/95	9	9	34	34	43	43	21%	79%
05/07/95	13	22	18	52	31	74	42%	58%
05/08/95	24	46	50	102	74	148	32%	68%
05/09/95	53	99	47	149	100	248	53%	47%
05/10/95	63	162	41	190	104	352	61%	39%
05/11/95	87	249	66	256	153	505	57%	43%
05/12/95	76	325	148	404	224	729	34%	66%
05/13/95	74	399	95	499	169	898	44%	56%
05/14/95	226	625	970	1,469	1,196	2,094	19%	81%
05/15/95	908	1,533	3,237	4,706	4,145	6,239	22%	78%
05/16/95	561	2,094	1,483	6,189	2,044	8,283	27%	73%
05/17/95	473	2,567	1,803	7,992	2,276	10,559	21%	79%
05/18/95	375	2,942	1,083	9,075	1,458	12,017	26%	74%
05/19/95	488	3,430	1,141	10,216	1,629	13,646	30%	70%
05/20/95	300	3,730	586	10,802	886	14,532	34%	66%
05/21/95	237	3,967	2,396	13,198	2,633	17,165	9%	91%
05/22/95	208	4,175	524	13,722	732	17,897	28%	72%
05/23/95	431	4,606	5,809	19,531	6,240	24,137	7%	93%
05/24/95	260	4,866	833	20,364	1,093	25,230	24%	76%
05/25/95	592	5,458	12,384	32,748	12,976	38,206	5%	95%
05/26/95	420	5,878	2,611	35,359	3,031	41,237	14%	86%
05/27/95	410	6,288	928	36,287	1,338	42,575	31%	69%
05/28/95	662	6,950	2,490	38,777	3,152	45,727	21%	79%
05/29/95	554	7,504	2,084	40,861	2,638	48,365	21%	79%
05/30/95	425	7,929	689	41,550	1,114	49,479	38%	62%
05/31/95	721	8,650	1,953	43,503	2,674	52,153	27%	73%
06/01/95	459	9,109	602	44,105	1,061	53,214	43%	57%
06/02/95	466	9,575	3,766	47,871	4,232	57,446	11%	89%
06/03/95	1,375	10,950	1,946	49,817	3,321	60,767	41%	59%
06/04/95	462	11,412	947	50,764	1,409	62,176	33%	67%
06/05/95	297	11,709	683	51,447	980	63,156	30%	70%
06/06/95	166	11,875	932	52,379	1,098	64,254	15%	85%
06/07/95	91	11,966	197	52,576	288	64,542	32%	68%
06/08/95	232	12,198	182	52,758	414	64,956	56%	44%

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Appendix B. (Page 2 of 2)

Date	Small Trap Daily	Small Trap Cumulative	Large Trap Daily	Large Trap Cumulative	Combined Daily	Combined Cumulative	Small Trap % of Combined Daily Catch	Large Trap % of Combined Daily Catch
06/09/95	92	12,290	177	52,935	269	65,225	34%	66%
06/10/95	251	12,541	394	53,329	645	65,870	39%	61%
06/11/95	402	12,943	647	53,976	1,049	66,919	38%	62%
06/12/95	330	13,273	1,140	55,116	1,470	68,389	22%	78%
06/13/95	203	13,476	320	55,436	523	68,912	39%	61%
06/14/95	198	13,674	317	55,753	515	69,427	38%	62%
06/15/95	204	13,878	235	55,988	439	69,866	46%	54%
06/16/95	115	13,993	167	56,155	282	70,148	41%	59%
06/17/95	275	14,268	375	56,530	650	70,798	42%	58%
06/18/95	280	14,548	606	57,136	886	71,684	32%	68%
06/19/95	186	14,734	260	57,396	446	72,130	42%	58%
06/20/95	70	14,804	94	57,490	164	72,294	43%	57%
06/21/95	88	14,892	114	57,604	202	72,496	44%	56%
06/22/95	136	15,028	340	57,944	476	72,972	29%	71%
06/23/95	95	15,123	247	58,191	342	73,314	28%	72%
06/24/95	93	15,216	275	58,466	368	73,682	25%	75%
06/25/95	98	15,314	147	58,613	245	73,927	40%	60%
06/26/95	15	15,329	75	58,688	90	74,017	17%	83%
06/27/95	16	15,345	57	58,745	73	74,090	22%	78%
06/28/95	98	15,443	84	58,829	182	74,272	54%	46%
06/29/95	39	15,482	54	58,883	93	74,365	42%	58%
06/30/95	9	15,491	9	58,892	18	74,383	50%	50%
Total	15,491	15,491	58,892	58,892	74,383	74,383	21%	79%

Appendix C. Daily population estimates of outmigrating sockeye salmon smolt, Chignik Lakes, 1995.

Date	Population Estimate	95% CI Lower	95% CI Upper
06-May	6,993	2,118	11,868
07-May	5,042	1,433	8,650
08-May	12,035	3,895	20,175
09-May	16,263	5,387	27,139
10-May	16,914	5,617	28,211
11-May	24,883	8,432	41,333
12-May	36,430	12,513	60,347
13-May	27,485	9,352	45,618
14-May	194,509	68,392	320,625
15-May	674,112	237,933	1,110,292
16-May	332,421	117,144	547,698
17-May	370,152	130,482	609,822
18-May	240,991	83,972	398,010
19-May	278,342	95,031	461,652
20-May	153,984	51,834	256,134
21-May	473,850	156,703	790,997
22-May	134,113	43,553	224,673
23-May	1,186,053	378,780	1,993,326
24-May	200,444	62,905	337,983
25-May	2,379,654	750,891	4,008,417
26-May	555,852	175,109	936,595
27-May	216,456	73,859	359,052
28-May	463,005	168,124	757,886
29-May	349,865	134,746	564,983
30-May	134,641	54,379	214,904
31-May	300,323	126,436	474,211
01-Jun	133,760	58,308	209,212
02-Jun	533,528	233,628	833,428
03-Jun	418,678	183,260	654,097
04-Jun	185,735	79,328	292,143
05-Jun	135,354	56,351	214,357
06-Jun	159,253	64,681	253,824
07-Jun	43,973	17,092	70,854
08-Jun	50,249	19,113	81,386
09-Jun	32,650	12,315	52,984
10-Jun	78,287	29,942	126,632
11-Jun	81,735	39,056	124,413
12-Jun	84,249	45,506	122,993
13-Jun	23,697	13,725	33,669
14-Jun	29,372	17,928	40,816
15-Jun	25,037	15,245	34,830
16-Jun	16,083	9,703	22,464
17-Jun	40,782	24,301	57,263
18-Jun	61,770	35,761	87,779
19-Jun	34,982	19,348	50,616
20-Jun	14,700	7,564	21,836
21-Jun	21,287	10,383	32,192
22-Jun	60,253	27,715	92,791
23-Jun	54,160	22,262	86,058

-Continued-

Appendix C. (Page 2 of 2)

Date	Population Estimate	95% CI Lower	95% CI Upper
24-Jun	77,706	27,226	128,185
25-Jun	45,933	12,113	79,752
26-Jun	16,873	4,238	29,509
27-Jun	13,686	3,374	23,998
28-Jun	34,121	8,911	59,331
29-Jun	17,436	4,390	30,481
30-Jun	3,375	594	6,155
Total	11,313,517	4,062,384	18,564,649

[a] The large trap was inoperative on 28 and 29 May. Trap efficiency and resulting population estimate for this day was derived from the average percent of the small trap catches relative to the total smolt catch for two days prior and after 28 and 29 May.

Appendix D. Outmigrating sockeye salmon smolt estimates by age class and sample period for Chignik Lakes, 1994 and 1995.

Year	Sample Week	Number of Smolt (by Age) Age-0	Age-1	Age-2	Total
1994	05/03	[a]	230,760	150,700	381,461
	05/10	[a]	440,286	916,183	1,356,469
	05/17	[a]	957,880	1,285,745	2,243,625
	05/24	[a]	1,336,675	923,403	2,260,078
	05/31	[a]	914,759	581,342	1,496,102
	06/07	[a]	1,014,467	452,738	1,467,205
	06/14	[a]	779,846	216,308	996,153
	06/21	[a]	1,762,310	456,426	2,218,736
	06/28	[a]	299,455	33,809	333,264
	Total		**7,736,438**	**5,016,654**	**12,753,093**
1995	05/03	17,758	7,523	15,052	40,333
	05/10	47,514	206,276	1,052,966	1,306,756
	05/17	104,296	583,855	2,149,333	2,837,484
	05/24	122,549	998,742	3,178,626	4,299,917
	05/31	271,198	855,904	739,529	1,866,631
	06/07	85,617	225,604	83,619	394,840
	06/14	15,652	183,209	23,865	222,726
	06/21	9,283	264,598	16,017	289,898
	06/28	0	52,716	2,216	54,932
	Total	**673,867**	**3,378,427**	**7,261,223**	**11,313,517**

[a] Age-0 smolts not sampled.

Appendix E. Mean length, weight, and condition factor, and population by age and date of sockeye salmon smolt captured in the Chignik River, 1995.

		Length			Weight			Condition			Population			
Age	Week beginning	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Population Size	Mean Length	Mean Weight	Mean Condition
0	05/03	62	46.3	0.5	62	0.6	0.0	62	0.80	0.02	17,758	46.3	0.6	0.63
0	05/10	17	47.8	0.8	17	0.7	0.0	17	0.82	0.02	47,514	47.8	0.7	0.67
0	05/17	9	48.7	1.0	9	0.8	0.1	9	0.78	0.03	104,296	48.7	0.8	0.66
0	05/24	17	48.1	0.7	17	0.8	0.1	17	0.75	0.04	122,549	48.1	0.8	0.71
0	05/31	52	47.1	0.4	52	0.8	0.0	52	0.73	0.01	271,198	47.1	0.8	0.78
0	06/07	79	45.3	0.3	79	0.8	0.0	79	0.73	0.01	85,617	45.3	0.8	0.81
0	06/14	30	46.3	0.5	30	0.8	0.0	30	0.76	0.02	15,652	46.3	0.8	0.81
0	06/21	8	45.6	0.8	8	0.8	0.1	8	0.74	0.06	9,283	45.6	0.8	0.82
	Totals	274	46.4	0.2	274	0.7	0.0	274	0.74	0.01	673,867	46.4	0.7	0.74
1	05/03	27	76.8	2.6	27	3.4	0.3	27	0.70	0.02	7,523	76.8	3.4	0.70
1	05/10	68	76.8	1.2	68	3.6	0.2	68	0.76	0.01	206,276	76.8	3.6	0.76
1	05/17	59	76.0	1.2	59	3.6	0.2	59	0.78	0.01	583,855	76.0	3.6	0.78
1	05/24	104	66.3	0.9	104	2.4	0.1	104	0.79	0.01	998,742	66.3	2.4	0.79
1	05/31	165	60.2	0.7	165	1.9	0.1	165	0.79	0.01	855,904	60.2	1.9	0.79
1	06/07	201	60.5	1.0	201	2.3	0.2	201	0.86	0.03	225,604	60.5	2.3	0.86
1	06/14	284	56.5	0.6	284	1.7	0.1	284	0.84	0.01	183,209	56.5	1.7	0.84
1	06/21	303	54.0	0.4	303	1.4	0.0	303	0.84	0.01	264,598	54.0	1.4	0.84
1	06/28	63	54.8	0.7	63	1.5	0.1	63	0.88	0.02	52,716	54.8	1.5	0.88
	Totals	1,274	60.2	0.3	1,274	2.0	0.0	1,274	0.83	0.01	3,378,427	60.2	2.0	0.83
2	05/03	47	80.9	1.5	47	4.1	0.2	47	0.75	0.02	15,052	80.9	4.1	0.75
2	05/10	265	74.2	0.3	265	3.2	0.1	265	0.77	0.01	1,052,966	74.2	3.2	0.77
2	05/17	211	76.0	0.4	211	3.6	0.1	211	0.80	0.01	2,149,333	76.0	3.6	0.80
2	05/24	229	73.2	0.3	229	3.2	0.0	229	0.82	0.01	3,178,626	73.2	3.2	0.82
2	05/31	132	73.3	0.5	132	3.3	0.1	132	0.81	0.01	739,529	73.3	3.3	0.81
2	06/07	70	78.8	1.5	70	4.6	0.3	70	0.88	0.03	83,619	78.8	4.6	0.88
2	06/14	33	76.1	1.7	33	4.0	0.4	33	0.85	0.01	23,865	76.1	4.0	0.85
2	06/21	20	76.7	1.8	20	4.0	0.3	20	0.86	0.02	16,017	76.7	4.0	0.86
2	06/28	3	100.3	0.9	3	9.2	0.2	3	0.92	0.03	2,216	100.3	9.2	0.92
	Totals	1,010	75.1	0.2	1,010	3.5	0.0	1,010	0.80	0.01	7,261,223	75.1	3.5	0.80

Appendix F. Summary of mean length at age and percent age composition of outmigrating sockeye salmon smolt captured in the Chignik River for various years.

Outmigration Year	Smolt: Mean Length (mm) Age-1	Smolt: Mean Length (mm) Age-2	Smolt: Percent Age Composition Age-1	Smolt: Percent Age Composition Age-2	Parent Year Escapments: Black Lake[a]	Parent Year Escapments: Chignik Lake[a]	Total Adult Return Produced by Parent Year Escapment[b]: Black Lake	Total Adult Return Produced by Parent Year Escapment[b]: Chignik Lake
1957	80	83	24	75	257,000	278,000	526,000[c]	776,000[c]
1958	78	79	9	90	289,000	201,000	195,000[d]	534,000[d]
1993	80	91	73	27	658,000	336,000	[e]	[e]
1994	67	77	61	39	361,000	383,000	[e]	[e]
1995	60	75	30	64	364,000	406,000	[e]	[e]

[a] Historically Black Lake stocks have been generalized as age-1 smolts and Chignik Lake stocks as age-2 smolts.

[b] Total adult return includes estimated total catch and escapment of sockeye salmon. Catch figures do not include subsistence harvests.

[c] Adults returned in 1960.

[d] Adults returned in 1961.

[e] Adults will return in 3 years.

Appendix G. Daily climatilogical observations, water temperature, water depth, and trap rpm at Chignik River, 1995.

Date	Time	Air (c)	Water (c)	Cloud Cover %	Wind Dir	Vel. (Mph)	Stream Guage (cm)	Trap RPM		Comments
								Small	Large	
06-May	1145	7.0	4.0	100	SE	0-5		4.50	4.90	
07-May	1145	8.0	4.0	100	SE	10-15		4.50	4.90	
08-May	1155	7.0	4.0	100	SE	5-10		5.00	5.25	
09-May	1145	7.0	4.0	100	SE	15-20	27	5.50	5.75	Set water gauge
10-May	1155	7.0	4.0	100	SE	0-5	38	7.25	6.75	
11-May	1155	7.0	5.0	90	SE	0-5	47	8.00	7.75	
12-May	1155	12.0	4.5	60	NW	0-5	53	8.50	8.00	
13-May	1155	-	-	100	-	0	56	8.00	7.75	No wind
14-May	1155	4.5	5.0	95	NW	20-25	58	9.50	8.75	
15-May	1155	8.0	4.0	90	NW	15-20	58	9.10	8.50	
16-May	1155	9.0	5.0	100	NW	0-5	55	9.00	8.10	
17-May	1155	5.5	5.0	100	SE	5-10	51	8.50	8.00	
18-May	1155	6.5	5.0	100	SE	5-10	52	8.50	7.75	
19-May	1155	8.0	5.0	100	SE	10-15	58	-	-	
20-May	1155	12.0	6.0	70	SE	15-20	71	6.25	9.00	No rain
21-May	1155	6.0	5.0	100	SE	15-20	76	5.75	9.25	
22-May	1155	10.0	5.0	80	NW	10-15	81	9.50	10.10	
23-May	1155	10.0	6.0	98	SE	0-5	84	-	-	
24-May	1155	9.0	7.0	50	NW	5-10	85	9.50	10.50	
25-May	1155	5.0	5.0	100	SE	15-20	84	9.25	10.00	
26-May	1155	8.0	6.0	80	NW	10-15	83	8.25	10.25	
27-May	1155	6.0	5.0	100	NW	5-10	79	9.00	9.25	
28-May	1155	8.0	6.0	100	NW	5-10	74	11.50	-	Lg. trap disabled
29-May	1155	8.0	6.0	80	NW	5-10	71	9.50	9.50	Lg. trap operating
30-May	1155	9.0	6.0	90	SE	5-10	64	9.50	9.00	
31-May	1155	7.0	6.0	90	SE	5-10	58	9.50	8.75	
01-Jun	1155	11.0	7.0	50	SE	0-5	56	8.75	8.50	
02-Jun	1155	8.0	6.0	40	NW	10-15	56	8.75	8.50	
03-Jun	1155	8.0	6.0	100	NW	20-25	53	8.25	8.25	
04-Jun	1155	11.0	7.0	90	SE	10-15	51	8.25	8.25	

-Continued-

Appendix G. (Page 2 of 2)

Date	Time	Air (c)	Water (c)	Cloud Cover %	Wind Dir	Vel. (Mph)	Stream Guage (cm)	Trap RPM		Comments
								Small	Large	
05-Jun	1155	9.0	7.0	100	SE	15-20	51	8.50	8.50	
06-Jun	1155	8.0	7.0	100	SE	10-15	51	8.75	8.25	
07-Jun	1155	8.0	7.0	100	SE	5-10	54	8.75	8.50	
08-Jun	1155	11.0	7.5	50	SE	5-10	55	9.00	8.75	
09-Jun	1155	7.0	7.0	90	NW	30-40	-	9.00	9.00	Water gauge out
10-Jun	1155	14.0	8.0	0	SE	20-25	-	9.50	8.85	Water gauge out
11-Jun	1155	14.0	10.0	0	SE	5-10	61	10.50	9.50	Reset water gauge
12-Jun	1155	12.0	9.0	50	SE	10-15	64	10.50	9.50	
13-Jun	1155	10.0	8.0	100	NW	0-5	69	11.00	9.85	
14-Jun	1155	9.0	8.0	100	SE	0-5	74	11.00	10.00	
15-Jun	1155	13.0	9.0	20	NW	10-15	71	11.00	10.00	
16-Jun	1155	10.0	8.0	100	NW	0-5	66	10.50	9.75	
17-Jun	1155	8.0	8.0	100	NW	15-20	64	10.50	9.50	
18-Jun	1155	9.0	8.0	100	SE	10-15	61	9.75	9.00	
19-Jun	1155	10.0	8.5	100	SE	0-5	62	10.0	9.00	
20-Jun	1155	11.0	9.0	60	NW	0-5	61	9.75	9.25	
21-Jun	1155	8.0	8.5	100	SE	10-15	60	9.35	9.25	
22-Jun	1155	9.0	8.0	100	NW	5-10	56	9.25	9.00	
23-Jun	1155	11.0	9.0	95	NW	10-15	53	9.00	8.50	
24-Jun	1155	11.0	9.0	95	NW	10-15	53	9.00	8.50	
25-Jun	1155	13.0	9.5	90	NW	0-5	51	8.50	8.50	
26-Jun	1155	10.0	9.0	90	SE	5-10	48	8.00	8.25	
27-Jun	1155	10.0	9.0	100	SE	5-10	48	8.50	8.25	
28-Jun	1155	11.0	9.0	100	SE	5-10	56	9.00	8.75	
29-Jun	1155	10.0	9.0	100	SE	5-10	59	9.25	8.75	
30-Jun	-	-	-	-	-	-	-	-	-	Pulled traps